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WORKING PARTY ON MOVEMENT OF SOLIDS

REPORT NO. 8

PROPOSAL FOR MOVEMENT OF SOLIDS

by

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Introduction:

An evaluation of the French transportation proposal known as the "Flying Feeder" or "Mobile Pipeline" (Working Party on Movement of Solids Report #7 by R.P. Charbonnier) suggests that this method now under development at the pilot plant scale is in principle attractice. The moving trough used can be thought of as a railway operating at a high coefficient of utilization and thus the method has the advantages of the railway system of guided, low-friction movement without the attendant disadvantage of very high capital cost. Particles, even lumps of reasonable size, can be moved at speeds considerably greater than the limits of pipelining (about 5 miles per hour) in an essentially automatic operation. It is likely that the installation cost would be greater than the construction of a pipeline, but the higher speeds that are possible may make the unit ton-mile capital cost lower than solids pipeline or other alternative methods. There is the additional advantage as compared to the solids pipeline that little cost would be expected in the preparation, charging and discharging steps. For some products (including some types of coal) the size cannot be reduced because of the limitations of the application at delivery so that present solids pipeline methods do not present a practical alternative.

This Proposal:

The present proposal for the movement of solids depends upon the overall concept of the French suggestion, but differs materially in the choice of propulsion and suspension methods. In essence, the present suggestion depends upon the application of the linear induction motor to the moving trough system and, to take advantage of the inherent high speed characteristics of this type of motor, a simple method of achieving air suspension is put forward as being compatible with this type of propulsion.

The linear induction motor may be described as essentially a three phase standard electrical induction motor with an infinitely high radius of curvature and thus capable of achieving linear motion. To achieve a high rate of energy release it is necessary (at a given frequency, the lower the frequency the lower the acceptable speed of the motor) for the relative motion of the "rotor" and the "stator" to be quite high as in a conventional machine. In fact Lathwaite* has claimed that the absolute advantage of the linear induction motor over more conventional motors driving through a gear train and wheels is not achieved until a relative speed of about 120 miles per hour is reached.

It is one of the main objectives of this report to point out that in the application to moving troughs where there is always a return trough movement similar to a conveyor system, this high relative speed can be achieved by placing the "rotor" on the trough moving one way and the "stator" on the returning trough with the result that the speed relative to the ground is reduced to one-half the relative trough speed. As far as is known this is a

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see for example —
*Laithwaite, E.R., Linear Induction Motors, Interavia, 8, 1962, 1029-30.

novel suggestion concerning the application of this type of motor.

The advantage of the linear induction motor stems mainly from the fact that the force is transferred across distance by disturbance to magnetic fields rather than through geared wheeled friction drives. The transmitted force does not depend upon the weight of the moving device since friction is not necessary for the propulsion. Further, as the degree of friction to the support rail is of no consequence, no provision for slippery conditions need be made. Similarly for braking, a reversal of the magnetic field is all that is required. As the motor is stretched out flat, cooling is readily achieved. High unit energy outputs are possible because the main theoretical limitation on the output of an electrical motor is the rate of cooling that can be achieved. Further, in the motor arrangement advocated by Laithwaite and British Railways, it is possible to feed the "stator" magnetic field on both sides of the "rotor" which is by and large impossible with conventional motors. The force moving the trough is released uniformly along the length of the unit rather than at spaced points along the length as with conventional drives. By making both "rotor" and "stator" move oppositely to one another by mounting each motor component on side-by-side troughs moving in opposite directions (in addition to having the advantage already noted of reducing the critical speed relative to the ground) offers a method of taking down-hill and up-hill movement automatically into account. As one trough moves down-hill its partner is moving up-hill — the tendency of one side to speed up provides an equal and opposite thrust which assists the other trough of the unit up-hill.

Suspension:

Even with the possible reduction in acceptable critical speed by having both motor components move on adjoining oppositely moving troughs, the speed of the troughs will still be high. This high speed when conventional wheel supports are used suggests high frictional losses and it is suggested here that a simple method of air suspension could be used to obviate this difficulty. For the case where a trough 6" across and 6" deep is visualized, then for coal with a bulk density of 50 lbs per cubic foot an air pressure of not much greater than 25 lbs per square foot would be all that is required to achieve air suspension. It is suggested that this necessary pressure could be easily generated by the now efficiently powered translational movement of the trough by means of louvers installed on the side of the trough to deflect air into the suspension space. Of course conventional wheels are required to guide the trough and support it at start-up. The frictional resistance due to these wheels would tend to rise as the speed increased, but would decrease as the air pressure built up. This suggests the possibility of there being an optimum speed which may or may not be compatible with the linear induction motor characteristics. Another difficulty may also be that no suitable sealing method could be developed without having excessive air leakage.

Capacity:

The capacity of a trough 6" wide and loaded to a depth of 6" of coal at 50 lbs per cubic foot at 60 mph could move 14 million tons of coal per 300 day year.

Experimental Unit:

A full scale trial of this proposed method of transportation could be made at low cost.

A suggested experimental arrangement would be a six foot diameter circle of two troughs arranged concentrically to travel on two circular tracks. The "stator" would be attached to the side of one circular trough, and the "rotor"- actually a sheet of aluminum fitting between the "stator" field poles — would be mounted on the other circular trough facing the first. For experimental purposes the pole pieces could be made from plain carbon steel and hand wound with copper wire. Various methods of deflecting air for the suspension, and methods of obtaining a suitable air seal could be evaluated.

As this would be a full-scale trial presumably reasonably accurate cost data could be obtained.

It is expected that a preliminary trial could be conducted for a modest outlay.

Recommendation:

It is recommended that a simple trial of this new transportation method be undertaken by the Division.